

and 11 under 35 U.S.C. § 103(a) as being unpatentable over Lin and Wong et al. as applied to claim 6, and further in view of Hung et al.

As indicated previously herein, Applicants have canceled claims 1-3 and 5, and amended claims 4 and 6, rendering the Examiner's rejections moot. To the extent, however, that the Examiner may consider applying the above-mentioned rejections to claims 4 and 6 as amended, Applicants respectfully submit that such rejections would be improper since the cited reference fail to disclose or suggest each and every element of Applicants' amended claims 4 and 6. See M.P.E.P. §§ 2131 and 2142.

Applicants' invention as recited in amended claim 4 is directed to an etching method for exposing a layer of Cu by etching a layer of SiN_x on the layer of Cu with an etching gas constituted of C, H, and F, wherein the gas constituted of C, H, and F is CHF₃.

In contrast, the Yang et al. reference discloses exposing a layer of "aluminum (Al) or an aluminum-copper (Al—Cu) alloy" by etching three layers of intermetal dielectric on the (Al) or (Al—Cu) alloy layer using three distinct plasma etching processes, one of which uses a high-density plasma etcher and an etchant gas that includes one or more of the following gases: oxygen (O₂), trifluoro-methane (CHF₃), carbon tetrafluoride (CF₄), and carbon dioxide (CO₂). Col. 3, lines 37-67; col. 4, lines 1-8.

Therefore, the Yang et al. reference does not disclose or suggest at least an etching method for exposing a layer of Cu by etching a layer of SiN_x on the layer of Cu. Yang et al. discloses etching either a layer of Al or a layer of (Al—Cu) alloy, but not a layer of Cu. Applicants have found that Cu oxidizes more readily than Al or alloys of Al,

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such as Al—Cu alloy, which thereby increases the resistance of Cu wiring and reduces the performance of the semiconductor device. By using an etching gas including C, H, and F, Applicants have reduced the oxidization of portions of the Cu layer exposed during an etching process. As a result, the performance of the semiconductor device may not be substantially degraded by the etching process. Therefore, Applicants respectfully submit that amended claim 4 is allowable because the Yang et al. reference does not disclose or suggest each and every element of amended claim 4.

Applicants' invention as recited in amended claim 6 is directed to an etching method for exposing a layer of Cu by etching a layer of SiN_x on the layer of Cu. The method includes a step in which a processing gas containing a gas constituted of C, H, and F, and O_2 is raised to plasma and the SiN_x layer on the Cu layer is etched using a photoresist layer having a specific pattern formed therein, thereby exposing the Cu layer. The method also includes a step in which H_2 is introduced into said processing chamber and an H_2 plasma process is implemented on the Cu layer that has become exposed by raising the H_2 to plasma.

The Examiner rejected claim 6 under 35 U.S.C. § 103(a) as being unpatentable over Lin in view of Wong et al. Applicants' respectfully submit that the Lin and Wong et al. references, taken singly or in combination, fail to disclose or suggest each and every element in Applicants' amended claim 6. Neither the Lin nor the Wong et al. references discloses or suggests at least an etching method for exposing a layer of Cu by etching a layer of SiN_x on the layer of Cu, wherein, following the etching of the layer of SiN_x , a step in which H_2 is introduced into said processing chamber and an H_2 plasma process is implemented on the Cu layer that has become exposed by raising

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the H₂ to plasma. Applicants have found that it is difficult to completely prevent oxidation of the Cu layer and entry of C and F into the Cu layer during etching of the SiN_x layer. By introducing H₂ into the processing chamber and raising the H₂ top plasma, the Cu layer may be substantially deoxidized and the C and F may be substantially eliminated from the Cu layer. Therefore, Applicants respectfully submit that amended claim 6 is allowable because the Lin and Wong et al. references, taken singly or in combination, do not disclose or suggest each and every element of amended claim 6.

Furthermore, the other cited reference, Hung et al. (U.S. Pat No. 6,380,096) fails to overcome the deficiencies of the Yang et al., Lin, and Wong et al. references.

Accordingly, Applicants submit that amended independent claims 4 and 6 are allowable. Furthermore, Applicants submit that claims 7-12 are allowable by virtue of their dependency on claim 6 as well by their additional recitations of novel and non-obvious subject matter. Therefore claims 4 and 6-12 should be allowable.

Applicants respectfully request the reconsideration and reexamination of this application and the timely allowance of the pending claims.

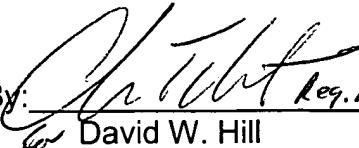
If the Examiner believes that a telephone conversation might advance prosecution, the Examiner is cordially invited to call Applicants' representative at 571-203-2739.

Applicants respectfully submit that the Office Action contains numerous assertions relating to the related art and the claims. Regardless of whether those assertions are addressed specifically herein, Applicants decline to automatically subscribe to them.

Please grant any extensions of time required to enter this response and charge
any additional required fees to our Deposit Account No. 06-0916.

Respectfully submitted,

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Dated: June 13, 2003
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David W. Hill
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APPENDIX TO THE AMENDMENT

IN THE CLAIMS:

Please cancel claims 1-3 and 5 without prejudice or disclaimer, amend claims 4 and 6, and add new claim 12, as follows:

4. (Amended) An etching method for exposing a layer of Cu by etching a layer of SiN_x on the layer of Cu with an etching gas constituted of C, H, and F [according to claim 1], wherein;

 said gas constituted of C, H₁ and F is CHF₃.

6. (Amended) [A plasma processing] An etching method for exposing a layer of Cu by etching a layer of SiN_x on the layer of Cu, wherein [comprising]:

 a step in which a processing gas containing a gas constituted of C, H₁ and F and O₂ is raised to plasma and an [SiN_x] SiN_x layer on a Cu layer is etched using a photoresist layer having a specific pattern formed therein, thereby exposing said Cu layer;

 [a step implemented after said etching step, in which said photoresist layer is ashed;] and

 a step [implemented after said ashing step,] in which H₂ is introduced into said processing chamber and an H₂ plasma process is implemented on said Cu layer that has become exposed by raising the H₂ to plasma.

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